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SNAILS FROM CALIFORNIA CAVES

BY

ALLYN G. SMITH

Research Malacologist, California Academy of Sciences

Several years ago a systematic exploration of California caves was undertaken by members of the Stanford Grotto, National Speleological Society. More recently, this work has been extended to certain caves in Nevada, Arizona, and Mexico and the entire work is now being carried on under the auspices of the Western Speleological Institute, located in Santa Barbara, California. Scientific collections of fauna, flora, minerals, and other materials are being assembled and accurate records are being kept by the Institute.

Among the fauna taken by the cave explorers are several species of land snails, some of which are of more than passing interest. The initial lot of these snails was made available for study through the courtesy of Dr. Myra Keen, Department of Mineral Sciences, Stanford University. Subsequently, more snails were collected during further explorations and were sent in by Edward A. Danehy, Research Chairman of the Stanford Grotto, and by Raymond deSaussure and Arthur L. Lange of the Western Speleological Institute.

Most of the snails collected by these speleologists represent two relatively common species living in the Mother Lode area in the foothills of central California, where many limestone caves are located. These are *Monadenia mormonum* (Pfeiffer) and *Helminthoglypta cypreophila* ("Newcomb" Binney & Bland). They are not true cave snails. In fact, so far as known there are no true cave mollusks in the strict sense anywhere on the west coast of North America. Normally, snails of these and other species of the California foothills are found in rock piles or in thick brush, briers, or nettles, usually

along water courses where the right conditions of moisture, shade, and food exist. Generally they go below the surface during the day, coming out to feed at night or on dark, rainy days. The entrances of caves often provide these habitat requirements. This could easily account for the occurrence of land snails in caves, plus the added probability that they might be washed in through crevices or other obscure cave entrances.

One species of land snail, collected in two caves in Amador County, California, by members of the Stanford Grotto, proves to be a most unusual and remarkable find as it represents not only a new species but a new genus as well. In one sense, this is a rediscovery because it makes comparison possible with certain similar small California snails, thought to be fossil, which have puzzled land-snail specialists for considerably more than half a century.

Another species, *Pristiloma subrupicola spelaeum* (Dall), was collected in caves in Calaveras and Amador counties. One of these caves was the original locality at Cave City where the indefatigable collector, Henry Hemphill, first found this snail about seventy years ago. As the specimens taken by the Stanford speleologists constitute a rediscovery of the species, and as shells from Hemphill's original collecting have been found at Stanford, an opportunity is afforded to redescribe and figure this little-known species.

The species of land snails found so far during the cave explorations in California are covered more fully in the following paragraphs.

Family HELMINTHOGLYPTIDAE

Monadenia (Corynadenia) hillebrandi (Newcomb).

Two dead shells, taken in Church Cave, Fresno County, probably should be so identified. This represents a considerable extension of the present known range of the species in Mariposa and Tuolumne counties. Shells of this race were collected first by the writer in 1940 in a rockslide of lime-

PLATE 1

Fig. 1. *Monadenia mormonum* (Pfeiffer) from Music Hall Cave, Calaveras Co., California, imbedded in a subaqueous calcite deposit. (C.A.S. Paleo. Type Coll., Hypotype 10293.)

Fig. 2. *Monadenia hillebrandi mariposa* A. G. Smith, n. ssp. Dorsal view of holotype from McLean Cave, Mariposa Co., California. Max. diam. 23.1 mm.

Fig. 3. Same. Ventral view.

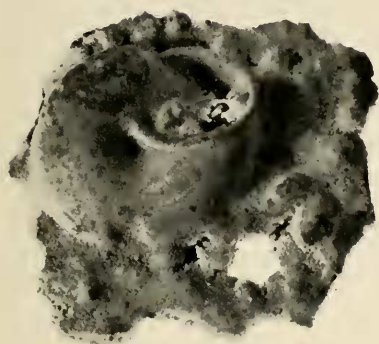
Fig. 4. Same. Side view.

Fig. 5. Same. Detail of sculpture on dorsal surface, ca. $\times 20$.

Fig. 6. *Haplotrema costatum* A. G. Smith, n. sp. Dorsal view of holotype, somewhat enlarged, from Lost Soldier's Cave, Tulare Co., California. Max. diam., 5.8 mm.

Fig. 7. Same. Ventral view.

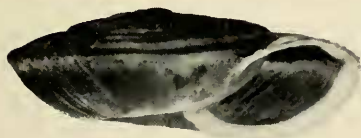
Fig. 8. Same. Side view.



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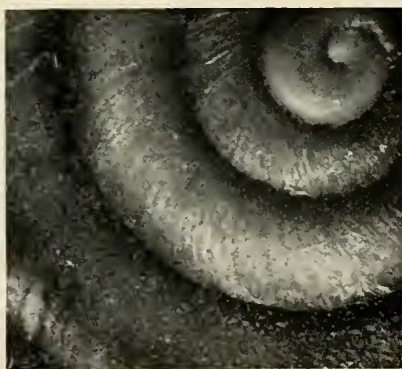
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stone near Boyden's Cave, and later by the Chaces of San Diego, California, in the same vicinity. No living snails of this race have been reported. As the available shells collected so far are poorly preserved, their relationship to *M. hillebrandi* from farther north must await further collecting before being finally settled.

***Monadenia (Corynadenia) tuolumneana* Berry.**

Dead shells were collected in two Tuolumne County localities by Raymond deSaussure in 1954: Crystal Butterfly Cave, one specimen (C.A.S. 34679), and Crystal Tuolumne Cave, several specimens (C.A.S. 34678). They agree in essential particulars with Berry's description of this relatively new species of *Monadenia*.

***Monadenia (Corynadenia) hillebrandi mariposa* A. G. Smith, new subspecies.**

(Pl. 1, figs. 2, 3, 4, and 5.)

HOLOTYPE: Shell bi-convex, depressed, umbilicate, acutely carinate. Whorls $5\frac{1}{8}$, the first $1\frac{3}{4}$ turns representing the nuclear stage. Umbilicus wide, vortex-shaped, contained about five times in the major diameter, and only slightly impinged upon by the reflection of the peristome. Peripheral carination formed by narrow shallow channels, the upper one deeper and extending over the final two or three whorls above the suture in such a way as to expose the keel. Sculpture of the nuclear whorls consisting of an array of closely-set papillations typical for the genus. Succeeding whorls decorated with rough irregular lines of growth, with scattered rounded papillae that become somewhat elongated and arranged spirally on the body whorl, giving the shell a dull granular appearance. Aperture set at an angle of 45° , the peristome reflected but not recurved, the edge sharp, with the upper portion flared slightly above the dorsal plane of the body whorl, angled at the termination of the peripheral keel, connected basally by a well-developed wash of callus, and white inside. Color of the shell reddish brown above and lighter below, especially in the umbilical area, with a single dark red-brown revolving band about one millimeter wide, bordered above and below by light colored narrower bands, the lower one coinciding with the peripheral keel or situated just below it. Maximum diameter, 23.1; minimum diameter, 18.6; height, 9.2; umbilicus diameter, 4.4 mm.

California Academy of Sciences Palco. Type Coll. 10283, a dead but well-preserved shell taken from the floor of McLean Cave, Mariposa County, California (Sec. 20, T2S, R18E, MDM); collected in the zone of twilight to total darkness by Raymond deSaussure, November 16, 1953. (Western Speleological Institute Locality C-146.)

PARATYPES: 15 adult shells and 4 juvenile specimens, collected with the holotype, all dead, in from fair to poor condition, some covered with a tenacious layer of hardened reddish brown mud. Paratypes to be placed in the mollusk collections of the California Academy of Sciences (Paleo. Type Coll. 10284, 10285), the U. S. National Museum, the Academy of Natural Sciences of Philadelphia, Stanford University, the Los Angeles County Museum, the San Diego Society of Natural History, and the private collections of S. S. Berry, W. O. Gregg, M. L. Walton, and Walter Miller.

OTHER LOCALITIES: One dead adult and one badly smashed juvenile specimen taken in Barber Cave, Mariposa County, California (Sec. 20, T2S, R18E, MDM, USGS Yosemite Quad.) in the same general vicinity as McLean Cave, by Raymond deSaussure, November 16, 1953. (Western Spel. Inst. C-147). These are C.A.S. 34818.

REMARKS: Measurements of 10 specimens from the type lot of *M. h. mariposa* yield the following data:

	Max. Diam.	Min. Diam.	Height	Umbilicus	No. Whorls
Largest shell	25.4 mm.	20.6 mm.	10.4 mm.	5.3 mm.	5 $\frac{5}{8}$
Smallest shell	20.9	17.4	8.3	4.1	5
Average of 10	23.5	19.3	9.5	4.6	5 $\frac{3}{8}$

The ratio of average maximum diameter to average umbilicus diameter is 5.1.

This new race of California mountain snail is remarkable for its unusually acute carination, resembling that of *Monadenia circumcarinata* (Stearns). It appears to be quite closely related to *M. tuolumneana* Berry recently described from "among limestone rocks at the top of cliff above Crystal Cave, Baker Ranch, near Tuolumne City, Tuolumne County, California," which is also a carinate race. *Monadenia h. mariposa* differs from *M. tuolumneana* in its pinched-in carina whereas the carina of the latter, while acute, does not have this peculiar feature. In addition, *M. h. mariposa* has a somewhat larger and a slightly more flaring umbilicus. Except for its acute pinched-in carina, *M. h. mariposa* is also related to *M. hillebrandi yosemitensis* from the Vernal Falls region of Yosemite Valley, which has a subearinate tendency and a low spire. It differs from *M. h. yosemitensis*, however, in having a smaller average size, a somewhat smaller umbilicus (though of the same vortex shape), and in the sparser papillate sculpture. Compared to typical *M. hillebrandi* from the Yosemite region it ranges smaller in size, is lower spired, lighter colored, and somewhat less widely umbilicate.

A point worthy of note is the habitat of these races of *M. hillebrandi* in areas of limestone outcrops, as indicated by their occurrence in or near limestone caves in both Tuolumne and Mariposa counties. In Kings Canyon

National Park shells of *M. hillebrandi*, indistinguishable from typical central California specimens, have been collected by the author and by Mr. E. P. Chace of San Diego, California, near the entrance to Boyden's Cave. Mr. deSaussure has also taken this southern race in Church Cave in Fresno County. These last two caves are both in limestone. All central California material previously collected or reported has been found where the predominating rock is granite.

***Monadenia troglodytes* Hanna & Smith.**

Described as a fossil of Pleistocene Age by Dr. G Dallas Hanna and the writer from shells collected in Samwel Cave, Shasta County, during an earlier exploration by paleontologists of the University of California. A couple of dead shells of this species found by the Stanford speleologists outside the cave on a slope some distance away from the cave entrance indicate the possibility that this species may be found living somewhere in the vicinity.

***Monadenia circumcarinata* (Stearns).**

A single dead, bleached specimen, picked up on the ground near Cave Man Cave, south of Paper Cabin Ridge in Tuolumne County, proved to be this long lost and much sought for species. Its rediscovery, since confirmed, provided the first real clue to its exact habitat in the limestone along portions of the rim of the Canyon of the Tuolumne River (Hanna and Smith, 1954). This find proves the incorrectness of previously published localities for the remarkable species, first said to be near Turlock, in Stanislaus County, and later near Columbia, Tuolumne County.

***Monadenia mormonum* (Pfeiffer).**

Taken from nearly all of the limestone caves in the Mother Lode area of Amador, Calaveras, Eldorado, Mariposa, and Tuolumne counties by the cave explorers. Of all snail species collected, this was the most abundant.

***Helminthoglypta allyniana* (Berry).**

Several specimens taken in McLean and Barber Caves, Mariposa County.

***Helminthoglypta cypreophila* ("Newcomb" Binney & Bland).**

This was the next most frequently occurring snail in caves and was often collected along with *Monadenia mormonum* (Pfeiffer).

***Helminthoglypta tularensis* (Hemphill).**

Dead shells were collected deep in Haughton's Cave, Baleh Park, Tulare

County. Other poorly preserved specimens, long dead, taken from Cave No. 12-19, about 14 miles nne. of Springville, Tulare County, undoubtedly belong to this species.

Helminthoglypta ferrissi Pilsbry.

A large dead and decorticated adult specimen was found by Mr. deSaussure in Church Cave, Fresno County, along with a living juvenile and a fragmentary specimen. This race of *H. ferrissi* averages appreciably larger than the size of typical shells from Tehipite Valley, middle fork of the Kings River, the adult shell above mentioned having a major diameter of 34.2 mm. Other examples, including one fine adult found alive, were collected by the writer in 1940 near Boyden's Cave, along with dead specimens of the southern race of *Monadenia hillebrandi* (Newcomb).

Helminthoglypta proles (Hemphill).

One well preserved but dead shell and another broken specimen were taken from Juniper Cave, Plumas County. This represents a northward extension of range for the species, which is partially confirmed by specimens collected earlier in Bear Valley, near Emigrant Gap, at the northern edge of Placer County. The best shell from Juniper Cave fits the description of the species in all respects and is not referable to the smaller and thinner subspecies *H. p. mariposa* Pilsbry, which lives in the Yosemite Valley region.

Family CAMAENIDAE

Ammonitella yatesii Cooper.

Collected at two new cave locations not hitherto reported—Cave of the Catacombs (Miller's Cave) in Calaveras County and Pioneer Cave in Eldorado County. This curious species, the only living one of its genus, has a limited distribution in the Mother Lode region of California, having been described many years ago from specimens collected in and near the cave at Cave City, Calaveras County. A large series of topotypes were collected in February, 1954, by Mr. deSaussure several hundred feet inside the cave in the zone of total darkness. All were dead. Several years ago snails of this species were collected by E. P. Chace in limestone talus near the mouth of Boyden's Cave in Fresno County, thus materially extending its geographic range southward. These were named *A. yatesii allyni* Chace based on minor differences between them and typical specimens from farther north. Dead shells of *A. y. allyni* were collected in Church Cave, Fresno County.

Family HAPLOTREMATIDAE

Haplotrema alameda Pilsbry.

A good-sized series of dead shells was taken in Sutter Creek Cave, Amador County; another comes from Pine Log Cave, and five additional specimens were collected in Small Cave, both located in Tuolumne County. A single dead shell of the subspecies *H. alameda fieldi* Pilsbry was found in Cave No. 12-1, Fresno County.

Haplotrema costatum A. G. Smith, new species.

(Pl. 1, figs. ^{6 7 8}3, 4, and 7.)

HOLOTYPE: A dead adult shell, small for the genus. Upper surface nearly flat, base with a wide and deep vortex-shaped umbilicus contained about two and one-half times in the major diameter. Color white underneath a thin, slightly yellowish periostracum. Whorls four and one-quarter, the nuclear turns about one and three-quarters, the latter smooth and tumid. Half of the first post-nuclear whorl decorated with closely spaced, subobsolete, transverse riblets similar to normal lines of growth. These give way abruptly to regularly spaced, coarse, rounded, sigmoidal riblets with channeled interspaces slightly wider than the riblets themselves. No spiral sculpture. Whorls moderately convex, with well impressed sutures. Outer lip descending, anteriorly protracted, reflexed at the upper edge by a small dimple, underneath which is a prominent, rounded denticle inside the aperture. Peristome thick, slightly recurved posteriorly, the outer and inner lips joined by a well defined ridge of callus. Maximum diameter, 7.5; minimum diameter, 6.2; height, 2.9; umbilicus diameter, 3.0 mm.

Holotype in California Academy of Sciences (Paleo. Type Collection, 10286) collected in total darkness at depth in Cave No. 12-19, Tulare County, California, by Raymond deSaussure, August 8, 1953.

PARATYPES: Two additional specimens taken with the holotype, the first a somewhat smaller dead adult shell, the second a dead but fresh juvenile. Paratypes are in the California Academy of Sciences (Paleo. Type Coll., 10286a, 10286b (A.G.S. 9451)).

REMARKS: This remarkable little species of *Haplotrema* does not appear to be related at all closely to any described species. Its major characters consist of the prominent ribbing in relation to size, the lack of spiral sculpture in the adult phase, and the strong denticle beneath the edge of the upper outer lip. In the somewhat better-preserved juvenile shell the nuclear whorls are translucent and shining. With a magnification of 40× some

extremely fine, closely spaced, spiral sculpture is seen on the early post-nuclear whorls.

Haplotrema costatum is nearest in size and sculpture to *H. caelatum* (Mazyek). It differs from the latter, however, in having a somewhat wider umbilicus, less tumid body whorl, and particularly in the configuration of the aperture and lip. In *H. costatum* this latter feature is similar to the lip structure of *H. sportella* (Gould) and *H. voyanum* (Newcomb) but without the denticle, whereas in *H. caelatum* the lip is simple, with a sharp edge even in the adult shell. On the basis of shell structure alone *H. costatum* probably belongs in the *H. sportella* group (section *Ancomena* H. B. Baker) along with *H. voyanum*.

Family ZONITIDAE

Pristiloma gabrielinum (Berry).

Three dead adults and one fine living specimen were collected in Church Cave, Fresno County, California; and another dead shell was found by Mr. deSaussure in Windy Cliff Cave, also in Fresno County. Comparison of these shells with others from the original habitat in the San Gabriel Mountains of Los Angeles County has indicated no appreciable differences. Thus the current find represents a considerable range extension for the species.

Pristiloma juniperum A. G. Smith, new species.

(Pl. 2, figs. 1, 2, and 3.)

HOLOTYPE: A dead adult shell with general characters of *P. gabrielinum* (Berry) from which it differs principally in the somewhat more tumid body whorl, correspondingly more capacious aperture, and the smaller tubular umbilicus. Whorls almost five and one-quarter. Like *P. gabrielinum*, this species exhibits a well defined "false suture" below the true suture where the top of the whorl is appressed and fused to the preceding one, a feature that is continuous, starting at the nucleus. The posterior portion of the outer lip is sharply angled just before joining the columella, the angle forming a carina that curves around the umbilicus for about half a turn, giving it its tubular shape. In the immediate area of this umbilical carina the shell material is roughened into several irregular, closely spaced, spirally arranged striae, a feature not present in *P. gabrielinum*. Maximum diameter, 5.8; minimum diameter, 4.9; height, 2.9; umbilicus diameter, 0.3 mm.

Holotype in the California Academy of Sciences (Paleo. Type Collection, 10287), collected on the floor and under rocks in the Cavern Room of

Juniper Cave, Plumas County, California (Western Speleological Institute, C-96), by Raymond deSaussure, July 20, 1953.

PARATYPES: Three specimens (two badly broken) collected with the holotype, (C.A.S. Paleo. Type Coll., 10287a, 10287b, 10287e (A.G.S. 9447)).

REMARKS: These snails appear to be worthy of a new name as they are sufficiently different from *P. gabrielinum*, with which the species has been compared, and also because the locality where it was discovered lies several hundred miles north of the known range of *P. gabrielinum*. It comes from an area that is not at all well known conchologically.

***Pristiloma chersinella* (Dall).**

A single dead specimen was taken in McLean Cave, Mariposa County.

***Pristiloma subrupicola spelaeum* (Dall).**

(Pl. 2, figs. 4, 5, and 6.)

?*V[itrea] subrupicola* . . . var. *spelaea* Dall, 1895, *Nautilus*, 9:27.

? *Pristiloma (Ogaridiscus?) subrupicola (?) spelaeum* (Dall), H. B. Baker, 1931, *Proc. Acad. Nat. Sci. Philadelphia*, 83:90.

Pristiloma subrupicola spelaeum (Dall), Pilsbry, 1946, *Acad. Nat. Sci. Philadelphia*, Mon. No. 3, vol. II, pt. 1, p. 418.

The original specimens on which this subspecies is based were unquestionably sent to Dall for identification. Probably they are in the U. S. National Museum at Washington, D. C. However, as Hemphill was in the habit of sending out only part of any lot he collected, it seemed certain that some of the original lot ought to be either in the California Academy

PLATE 2

Fig. 1. *Pristiloma juniperum* A. G. Smith, n. sp. Dorsal view of holotype, somewhat enlarged, from Juniper Cave, Plumas Co., California. Max. Diam., 5.8 mm.

Fig. 2. Same. Ventral view.

Fig. 3. Same. Side view.

Fig. 4. *Pristiloma subrupicola spelaeum* (Dall). Dorsal view of C.A.S. Lectotype 10288 from Cave City, Calaveras Co., California, coll. by H. Hemphill. Somewhat enlarged. Max. diam., 5.9 mm.

Fig. 5. Same. Ventral view.

Fig. 6. Same. Side view.

Fig. 7. *Spelcodiscoides spirellum* A. G. Smith, n. gen., n. sp. Dorsal view of holotype, somewhat enlarged, from Violin Cave, Amador Co., California. Max. diam., 6.8 mm.

Fig. 8. Same. Ventral view.

Fig. 9. Same. Side view.



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of Sciences where Hemphill's main collection is deposited, or in the Hemphill "duplicates" at Stanford University. A thorough search of the California Academy collection proved fruitless but Dr. Myra Keen discovered a lot of five specimens at Stanford labeled "*Pristiloma subrupicola spelaea* Dall, Calaveras Co., probably from Cave City, coll. H. Hemphill." Agreement between these shells and those collected at Cave City by the Stanford speleologists leaves little room for doubt that they are part of the original lot.

The largest of the Stanford specimens has been selected for illustration. Through the courtesy of Dr. Keen it has been deposited in the Paleo. Type Collection of the California Academy of Sciences as Lectotype 10288. The shell evidently contained the living animal when found. It has four and seven-eighths whorls and measures: max. diam., 5.9; min. diam., 5.2; height, 2.4; diam. of umbilicus, 0.5 mm. It is thin and pellucid, with a whitish luster that is more pronounced on the last whorl. Axial sculpture consists of some wrinkling near the sutures and in the vicinity of the umbilicus, but this does not cross the periphery of the whorls, which are smooth and without any traces of lines of growth. Spiral sculpture consists of extremely fine wavy lines that can be seen well only at magnifications of about 40× or higher, although some heavier spiral impressions occur in the umbilical region. The sutures are not deeply impressed but where the upper end of the peristome becomes fused with the preceding whorl during growth, another line shows through, giving the aspect of a false suture just above the true sutural groove. In shape, the shell agrees well with Pilsbry's figure of *Pristiloma subrupicola* (1946, p. 415, fig. 226), except that the umbilicus is wider.

The other four specimens in the Stanford lot agree in most particulars with the above account. Two also were collected living, are somewhat smaller, but have more whitish luster than the larger shell has. Measurements of them are as follows:

No. Whorls	Max. Diam.	Min. Diam.	Height	Diam. of Umb.
4 $\frac{7}{8}$	5.0 mm.	4.5 mm.	2.5 mm.	0.5 mm.
4 $\frac{1}{4}$	4.7 "	4.2 "	2.3 "	0.5 "

The remaining two are dead shells, both somewhat damaged.

The Stanford cave explorers collected this same species at the following localities, to which another is added where the writer found it later:

Cave at Cave City, Calaveras County, Stanford Grotto, 9-b; Edward Danahy, coll., July 1, 1950; 13 dead specimens (topotypes), C.A.S. 34819.

Black Chasm, near Volcano, Amador County, Stanford Grotto, 68, lot 2; Charles Moller, coll., January 15, 1951; a single dead and possibly somewhat fossilized specimen found about 120 feet down from the cave opening. (C.A.S. 34820.)

Violin Cave, Amador County, Stanford Grotto, 142; Edward Danehy and Arthur Lange, colls., November 25, 1951; two living specimens (preserved in alcohol) and two dead shells (C.A.S. 34821). The living specimens were found estivating about 50 feet from the entrance of the cave, in total darkness. The others were taken at the farthest point inside the cave where they appeared to have been washed, possibly through small crevices.

Rippled Cave, Amador County, Stanford Grotto, 144; Gil. Lang, coll., February 3, 1952; three living specimens (preserved in alcohol) and one additional juvenile preserved dry (C.A.S. 34822).

Bank of San Antonio Creek, near Sheep Ranch, Calaveras County; A. G. Smith, coll., May 18, 1952; a single dead adult specimen in a shaded rock-slide (C.A.S. 34823).

Family ENDODONTIDAE

Speleodiscoides A. G. Smith, new genus.

DESCRIPTION: Shell helical, small (7 mm. in diameter), fragile, disk-shaped, with flat or slightly concave spire, and with a wide, shallow umbilicus. Color white, the whorls being covered by a very pale horn-colored periostracum. Nuclear whorls about one and one-half, smooth and glossy, tumid; postnuclear whorls about five and one-half, tightly coiled, rounded, without internal teeth or other processes; aperture subcircular; lip simple, sharp, not entire. Sculpture consisting of fine growth lines and closely spaced, transverse growth ridges. Animal unknown. Genotype, the following species.

REMARKS: This genus does not seem to be closely related to any other from North America. Provisionally it is referred to the family Endodontidae but this must remain a problematical assignment until living specimens can be found and their anatomy investigated. It is closest in size, shape, and coiling of the whorls to *Helicodiscus* Morse, 1864, but differs from that genus in the lack of spiral sculpture and of any internal laminae or teeth. It may also be compared with the South American genus *Polygyratia* Gray, 1847, section *Systrophia*, as defined by Tryon & Pilsbry in the Manual of Conchology¹. Several species of the general shape and coiling of *Speleodiscoides* are reported from Colombia, Peru, and Ecuador. These are somewhat larger in size and although several are described as having no barriers or teeth inside the whorls, some have spirally striate sculpture that is lacking in *Speleodiscoides*.

¹ Thiele (1931, p. 597) gives *Systrophia* generic status in the family Systrophiidae.

Speleodiscoides spirellum A. G. Smith, new species.

(Pl. 2, figs. 7, 8, and 9.)

HOLOTYPE: A dead but well-preserved shell with general characters as described for the genus. Total whorls six and three-quarters, consisting of about one and one-half nuclear turns and five and one-half postnuclear turns. The embryonic tip is small but enlarges rapidly during the second half-turn, so that this portion of the nuclear whorls projects slightly above the plane of the first two postnuclear whorls. Spire very slightly concave except for the projecting nuclear area. Sutures well impressed. Umbilicus very wide and shallow. Maximum diameter, 6.8 mm.; minimum diameter, 6.4 mm.; height, 1.6 mm.

Holotype in the California Academy of Sciences (Paleo. Type Coll., 10289), collected in Violin Cave on South Fork of Dry Creek, west bank, Amador County, California (Sec. 4, T7N, R12E, MDM, USGS Pine Grove Quad.), by Edward Danchy and Arthur Lange, November 22, 1951, Stanford Grotto, 142.

PARATYPES: 33 specimens collected with the holotype, of which about 20 are full-grown though all are dead shells in a more or less bleached condition. Paratypes are in the California Academy of Sciences (Paleo. Type Coll., 10290, 10291, and 10292), Stanford University, the Los Angeles Museum, the San Diego Society of Natural History, the Academy of Natural Sciences of Philadelphia, the United States National Museum, and the private collections of Dr. S. S. Berry, Dr. W. O. Gregg, Walter Miller, M. L. Walton, and Leslie Hubricht.

OTHER LOCALITY: Black Chasm, near Volcano, Amador County, California, on the east side of the south branch of Sutter Creek, at an elevation of 2040 feet. Two lots were taken: the first containing nine bleached shells collected by Charles Moller, January 13, 1951 (C.A.S. 34824); the second, ten shells collected by Harold Treacy, May 5, 1951 (C.A.S. 34825). All were dead shells found deep down in this almost vertical shaft-like cave.

REMARKS: This remarkable small, closely-coiled, flat snail looks like a large *Helicodiscus* but the lack of internal teeth and the absence of even the slightest vestige of spiral sculpture immediately set it apart from this genus. Similar snail shells from the San Francisco Bay region have been mentioned in the literature by W. G. Binney (1886; 1890), Hanna (1939), and Pilsbry (1948) under the names *Helicodiscus lineatus* Say, *H. fimbriatus* var. *salmonensis* W. G. Binney, and *H. salmonaceus* W. G. Binney. Although specimens from these early collectings have been at hand for many years, the lack of sufficient specific information on them and the fact that they have not been taken by any collector since has caused hesitation in recognizing

them as part of the snail fauna of California. Discovery of these snails in fair quantity in two Amador County limestone caves leaves no doubt about their authenticity as well as their novelty. Although not one was found alive, several specimens in the type lot are fresh enough to lead one to the supposition that living snails of this species may be found by diligent search in the vicinity of the caves where the dead shells were collected.

DISCUSSION: Violin Cave is about eight miles southeast of the old gold settlement of Fiddletown (hence the name of the cave) and is around three or four miles air-line from Volcano and the Black Chasm location. Fiddler's Cave is nearby. The cave entrance is 30 feet above the South Fork of Dry Creek at the base of a massive marble outcrop. Mr. Danchy has furnished the following comments:

Violin Cave was almost dry when visited in November, 1951, although in the low, narrow crawlway where the estivating snails were found the gravel floor was damp. This point is approximately 50 feet from the entrance and was the beginning of the zone of total darkness. The cave is nearly horizontal and the farthest point reached is estimated as being 250 to 300 feet from the entrance. Here, soil and pebbles from the surface are accumulated below crevices. . . . It was in the crevices and upon the soil that the dead shells were found. Almost every cave I have seen has places where soil and debris come in from the surface, even though no openings are evident.

The snails taken from this cave were selected as the type lot because of the number of specimens collected, which permits a liberal distribution of paratypes. Measurements of the ten largest specimens are as follows:

<i>Dimension</i>	<i>Range</i>	<i>Average</i>
Maximum diameter	6.0 - 7.4 mm.	6.6 mm.
Height	1.4 - 1.6 mm.	1.5 mm.
Number of whorls	6¼ - 7	6¾

All the shells in the lot show marked similarity in characters and sculpture. They differ only in slight irregularities in the coiling of the whorls.

Black Chasm, where *Speleodiscoides* was first rediscovered, is located on a hilltop in an area of massive outcrops of marble, weathered smooth into fantastic shapes in places—a characteristic of several locations in the Mother Lode country. It is described as follows in the January, 1951, report of the Stanford Grotto:

It is an L-shaped vertical fissure in limestone, first entered by E. Sammis with a party in 1854. At that time the opening was about 18" across but has since been enlarged to a diameter of several feet in subsequent attempts to commercialize the cavern. The entrance confronts a steeply inclined mud slope composed of material washed in from above. Several vertical pitches follow before the first landing is reached—an estimated 120 feet below. From the entrance down to this landing there are found no foot- or hand-holds.

Fifty or sixty feet below the landing lies the bottom of the cavern—a series of interconnecting (?) lakes, the first of which has a length of about 70 feet. Depths were estimated to exceed 20 feet. Between the landing and the lake level occurs one mud platform. The entire downward route is mud-coated, but away from the range of debris the cavern walls appear unsoiled.

The snail shells were reported as being found in a side passage extending off from and above the first landing about 120 feet down from the mouth. How they found their way into this side passage is hard to imagine unless it has had some sort of surface connection.

The Black Chasm locality was visited by the writer in May, 1952. A fairly thorough search of likely-looking piles of marble and country rock in the vicinity was made on the theory that the snails in the cave had dropped or been washed in from the surface. No snails were found, however, either of this or any other species, possibly owing to the fact that over much of the entire area were evidences of surface alteration resulting from placer or other gold-seeking operations. Time was not available to devote a similar search around Violin Cave. The freshness of specimens from this location would appear to make such a search more likely to be successful if the species is still living.

Shells of *Speleodiscoides* from the San Francisco Bay region that are available for comparison consist of two from Sausalito from the Reverend Joseph Rowell Collection, and two others from the W. J. Raymond Collection. Of the latter, one was labeled as collected at Sausalito by Voy in 1872, the other being found by Professor Raymond himself at "Laundry Farm" in the vicinity of what is now Leona Heights, a suburb of Oakland. All these specimens were presumed to be fossil or at least semifossil, a view that now seems questionable in the light of recent finds. Two of the four shells are adult or nearly so. They do not have a fossil appearance. Of the other two, one is young; the second is badly worn and broken. Two of the good specimens have the following measurements:

CAS No.	AGS No.	Locality	Collection	Max. Diam.	Height	No. Whorls
34826	1937	Sausalito, Calif.	Rowell	5.5 mm.	1.5 mm.	5 $\frac{1}{4}$
34827	8811	?	Raymond	6.1 mm.	1.4 mm.	5 $\frac{3}{8}$

The two Raymond specimens were together in the same bottle, making it impossible to tell which one Voy collected and which Raymond himself found.

The principal account of these snails was furnished by J. G. Cooper and published in an early Bulletin of the California Academy of Sciences (Cooper, 1885). As copies of this Bulletin are not readily accessible, it is pertinent to this discussion to quote what Cooper has to say:

The fourth species (or specimens) of discoid sub-fossils have been in my

hands since 1871, when Mr. C. D. Voy brought them to me as discovered by him "in an Indian mound north of S. F. Bay." They are of the size and nearly the form of *Helicodiscus lineatus* (a species said to occur in California), but without a trace of teeth or sculpture. I considered them, however, imperfect specimens of that form until 1883, when W. O. Emerson found a few of the same much larger but more fossilized, near Haywards, on a sliding bank, where they seemed to come from under the roots of a large tree that had been undermined. These also are toothless, and some of both sent to Mr. Bland and Mr. Binney, have been decided to be a new species if not a new genus. As with the specimens of *Hyalina*, mentioned before, these were where they could not have been washed down by mountain streams.

Without living specimens it will be inadvisable to describe these, especially as their being found in an Indian mound is some indication that they may increase instead of decrease with the settlement of the country. The chances, however, seem to be in favor of their being cave dwellers or more northern species, introduced where found by birds, but not able to increase there.

This account is interesting from the information it gives about the conditions under which these snails were found. But it is all the more notable because of Cooper's supposition that they might be cave-dwellers. It is difficult to see the reasoning back of this unless Cooper, who was a keen observer, had information in addition to what he published. Whether it was a shrewd guess or was based on more tangible evidence, the fact remains it has been proved true after a span of nearly seventy years!

Compared with specimens from the two caves in Amador County, the San Francisco Bay shells have a flat rather than a slightly concave spire, less prominent transverse rib-sculpture, and the whorls appear to be not quite as tightly coiled. As these differences are so slight, and as only two good specimens are available for comparison, determination as to whether they constitute a recognizable geographic subspecies is left pending the collection of additional material from the San Francisco Bay area.

LIST OF CALIFORNIA CAVES EXPLORED, WITH RECORDS OF THE SNAIL SPECIES COLLECTED

SHASTA COUNTY*

1. SAMWEL CAVE. Sec. 5, T35N, R3W, MDM, Shasta Nat. Forest Map; Stanford Grotto, 23; Edward Danehy coll., September 20, 1950. Picked up on the ground on a prominent limestone bluff known as Eagle Rock, several hundred yards west of the cave entrance.

Monadenia troglodytes Hanna & Smith. Two bleached immature specimens. Discovery of this species outside of the cave indicates that it may be found living in the vicinity, though described origi-

* The counties are cited in geographic order from north to south.

nally as a Pleistocene fossil. The depressed spire of the specimens, though quite immature, gives credence to the correctness of the identification.

PLUMAS COUNTY

2. JUNIPER CAVE. Sec. 17, T23N, R10E, MDM, USGS Downieville Quad.; Western Speleological Inst., C-96, C-103, and C-105; Raymond de Saussure coll., July 20, 1953. Taken on the floor and under rocks in the Cavern Room in the zone of total darkness.

Helminthoglypta proles (Hemphill). One adult and one broken specimen; dead.

Pristiloma juniperum A. G. Smith, new species. Four specimens; dead.

AMADOR COUNTY

3. BLACK CHASM. $\frac{3}{4}$ mi. south of Volcano, Stanford Grotto, 68 and 104; Charles Moller and Harold Treacy colls., January 13 and May 5, 1951. "Found in side passage about 120 feet from the surface, in total darkness."

Speleodiscoides spirellum A. G. Smith, new genus and species. A total of 19 dead specimens, a few with deposits of small calcite crystals on one surface.

Pristiloma subrupicola spelaeum (Dall). A single dead specimen.

4. VIOLIN CAVE. Sec. 4, T7N, R12E, MDM, USGS Pine Grove Quad.; Stanford Grotto, 142, Edward Danchy and Arthur Lange colls., November 25, 1951. Named for its location near Fiddletown.

Speleodiscoides spirellum A. G. Smith. Thirty-four dead specimens. The type lot.

Pristiloma subrupicola spelaeum (Dall). Two living and two dead specimens.

5. RIPPLED CAVE. Sec. 23, T7N, R11E, MDM, USGS Big Trees Quad.; Stanford Grotto, 144 and 145, Gil Lang coll., February 3, 1952.

Helminthoglypta cypreophila (Binney & Bland). One living small adult.

Pristiloma subrupicola spelaeum (Dall). Three living specimens.

6. HARE CAVE. Sec. 31, T6N, R11E, MDM, USGS Sutter Creek Quad.;

Western Spel. Inst., C-34, Raymond deSaussure coll., April 5, 1953. Taken near second entrance in the twilight zone.

Helminthoglypta cypreophila (Binney & Bland). Three dead juveniles.

7. SUTTER CREEK CAVE. Sec. 29, T7N, R12E, MDM, USGS Pine Grove Quad.; Western Spel. Inst., C-61, Raymond deSaussure coll., May 25, 1953. Collected in lower right passage below a fissure, on the floor in total darkness.

Haplotrema alameda Pilsbry. Twenty-seven adult and three young specimens, all dead.

ELDORADO COUNTY

8. PIONEER CAVE. Sec. 18, T12N, R9E, MDM, USGS Auburn Quad.; Stanford Grotto, 31, Edward Danchy coll., October 7, 1950. "Cave open to daylight due to large entrance."

Monadenia mormonum (Pfeiffer). Collected in 1875 by J. G. Cooper but not found there by the Stanford speleologists.

Ammonitella yatesi J. G. Cooper. One dead adult specimen.

CALAVERAS COUNTY

9. CAVE OF THE CATACOMBS (MILLER'S CAVE). Sec. 2, T4N, R13E, MDM, USGS San Andreas Quad.; Stanford Grotto, 139, Edward Danchy coll., March 28, 1951, and November 23, 1951. "Taken in the zones of twilight and total darkness. Some appeared washed [in] and others seemed to be estivating."

Monadenia mormonum (Pfeiffer). Six living adults; eight adult and nine immature specimens, all dead.

Helminthoglypta cypreophila (Binney & Bland). Two adults and one immature specimen, all dead.

Ammonitella yatesi J. G. Cooper. Forty-three adults and 11 immature specimens, all dead.

10. CAVE OF THE SKULLS. North side of the Stanislaus River, about half way between Columbia and Vallecito; Stanford Grotto, 133, Edward Danchy coll., March 25, 1951. "Dead shells taken in the twilight zone."

Monadenia mormonum (Pfeiffer). One dead adult shell.

11. CAVE CITY CAVE. Sec. 14, T4N, R13E, MDM, USGS San Andreas Quad.; Stanford Grotto, 9a and 9b. Some shells taken January 7, 1950.

in total darkness several hundred feet from the nearest of the three cavern entrances. Others collected March 24, 1951, about 40 feet from the entrance in the twilight zone; Edward Danehy coll. Also, Western Spel. Inst., C-173 and C-174, several hundred feet into the cave in total darkness, probably washed in; Raymond deSaussure, coll., February 7, 1954.

Monadenia mormonum (Pfeiffer). Several dead specimens. Also collected by Hanna & Rixford (1923).

Helminthoglypta cypreophila (Binney & Bland). One dead adult.

Ammonitella yatesi (J. G. Cooper). Original lot found by L. G. Yates about 100 feet within the mouth of the cave (Cooper, 1868). Not reported by the Stanford Grotto but later a series of 60 specimens (topotypes) were collected by Raymond deSaussure of the Western Speleological Institute.

Pristiloma subrupicola spelaeum (Dall). Thirteen dead specimens (topotypes).

12. SHAW'S CAVE. Near Mercer's Cave; Stanford Grotto, 36, Edward Danehy coll., October 8, 1950. "Taken in total darkness. Washed in by water."

Monadenia mormonum (Pfeiffer). One dead (broken) adult and two immature specimens.

13. SNAIL CAVE. Sec. 4, T3N, R14E, MDM, USGS Columbia Quad.; Stanford Grotto, 73, Ray Bennett coll., March 10, 1951. "Taken in twilight zone." This cave and a number of others discovered have been given names for the first time. Snails were the only form of life found in Snail Cave.

Monadenia mormonum (Pfeiffer). One living and one dead adult.

14. CRYSTAL STANISLAUS CAVE. Sec. 23, T3N, R14E, MDM, USGS Columbia Quad.; Stanford Grotto, 56, Edward Danehy coll., November 25, 1950. Snails found "30 ft. in from entrance (twilight zone)." Also Western Spel. Inst., C-64, C-166, and C-169, Raymond deSaussure, coll., January 30, 1954. Found in various locations from the mouth of the cave to the twilight zone inside.

Monadenia mormonum (Pfeiffer). Two living immature specimens and 10 dead adults, some of large size, plus five immature shells, also dead.

15. GRAPEVINE GULCH CAVE. Sec. 22, T3N, R14E, MDM, USGS Columbia Quad.; Stanford Grotto, 95, Edward Danehy and Jack Jacobus colls.,

April 17, 1951. "Found in twilight zone." Also, Western Spel. Inst., C-3, C-5, and C-7, Raymond deSaussure, coll., February 2, 1953.

Monadenia mormonum (Pfeiffer). A total of 21 adult shells and six immature specimens from three collectings, all dead. Also one living juvenile specimen.

Helminthoglypta cypreophila (Binney & Bland). Two adults and three juvenile dead specimens.

16. BUCKEYE CAVE. One of the Grapevine Gulch caves; Western Spel. Inst., C-6, Raymond deSaussure coll., February 2, 1953. From the twilight zone.

Monadenia mormonum (Pfeiffer). Six dead specimens.

17. WOOL HOLLOW CAVE. Another of the Grapevine Gulch group. Raymond deSaussure coll., May 30, 1954, Western Spel. Inst. C-212, C-216, and C-217. Taken in several locations from the entrance to the zone of total darkness.

Monadenia mormonum (Pfeiffer). One immature living snail and eight other dead shells, five of which are adults. One of the last, broken and heavily incrustated, was found deposited with subaerial cave coral (Pl. 1, fig. 1).

18. KENNY'S GROTTA. Grapevine Gulch group of caves. Western Spel. Inst., C-215, Raymond deSaussure coll., May 20, 1954. From the floor in the twilight zone.

Monadenia mormonum (Pfeiffer). Five adult and four immature shells, all dead.

Helminthoglypta cypreophila (Binney & Bland). Two dead immature specimens.

19. MUSIC HALL CAVE. Between Moaning Cave and Parrott's Ferry; Western Spel. Inst., C-2, Raymond deSaussure coll., February 1, 1953. Taken in total darkness at the foot of a 150-foot fissure.

Monadenia mormonum (Pfeiffer). Fifteen adult and three immature specimens, several almost completely covered or imbedded in calcite crystal masses, a number of others clean or mud covered.

20. SPELEOGEN CAVE. Near Music Hall Cave; Western Spel. Inst., C-4, C-32, and C-50, Raymond deSaussure coll., February 2, April 4, and April 18, 1953.

Monadenia mormonum (Pfeiffer). Six adults and one immature, all dead, one found 160 feet down in a fissure.

Helminthoglypta cypreophila (Binney & Bland). A single living juvenile taken on the floor in the twilight zone.

TUOLUMNE COUNTY

21. RAILING CAVE. Sec. 34, T3N, R14E, MDM, USGS Columbia Quad.; Western Spel. Inst., C-67, C-77, C-81, and C-82, Raymond deSaussure coll., May 16, 1953. Taken in various locations in the cave.

Monadenia mormonum (Pfeiffer). Three living immature snails, plus eight adult and four juvenile dead specimens.

Helminthoglypta cypreophila (Binney & Bland). A single dead juvenile.

22. PINE LOG CAVE. Sec. 36, T3N, R14E, MDM, USGS Columbia Quad.; Western Spel. Inst., C-87, Raymond deSaussure coll., July 13, 1953. Snail shells collected throughout the cave in the zones of twilight to total darkness.

Monadenia mormonum (Pfeiffer). Eight adult and four juvenile shells, dead.

Haplotrema alameda Pilsbry. One broken adult.

23. SMALL CAVE. Sec. 36, T3N, R14E, MDM, USGS Columbia Quad.; Western Spel. Inst., C-88, Raymond deSaussure coll., July 13, 1953. From the twilight zone in the front part of the cave.

Monadenia mormonum (Pfeiffer). One adult and one immature, dead.

Helminthoglypta cypreophila (Binney & Bland). One dead juvenile.

Haplotrema alameda Pilsbry. Three adults and two juveniles, dead.

24. GOLD TOOTH CAVES. Sec. 14, T3N, R14E, MDM, USGS Columbia Quad.; Western Spel. Inst., C-161, Raymond deSaussure coll., January 30, 1954. On the ground, under rocks, daylight to twilight zones.

Monadenia mormonum (Pfeiffer). One broken adult and eight immature dead specimens.

Helminthoglypta cypreophila (Binney & Bland). One dead juvenile.

- 25: CRYSTAL TUOLUMNE CAVE. Sec. 21, T1N, R16E, MDM, USGS Sonora Quad.; Western Spel. Inst., C-183, Raymond deSaussure coll., February 6, 1954. On the ground just outside the entrance.

Monadenia tuolumneana Berry. Four adult and one immature, all dead specimens. (C.A.S. 34678.)

Helminthoglypta cypreophila (Binney & Bland). One dead adult.

26. CRYSTAL BUTTERFLY CAVE. Sec. 21, T1N, R16E, MDM, USGS Sonora Quad.; Western Spel. Inst., C-184, Raymond deSaussure coll., February 6, 1954. Just inside the entrance in the twilight zone.

Monadenia tuolumncana Berry. One dead adult. (C.A.S. 34679.)

27. CRYSTAL PALACE CAVE. Sec. 26, T3N, R14E, MDM, USGS Columbia Quad.; Western Spel. Inst., C-60 and C-64, Raymond deSaussure and Bill Wise colls., April 17 and May 24, 1953. In twilight zone.

Monadenia mormonum (Pfeiffer). One living immature snail and four dead (two adult) examples.

28. CAVE MAN CAVE. Sec. 28, T1N, R16E, MDM, USGS Tuolumne Quad.; Western Spel. Inst., C-30, Raymond deSaussure coll., April 2, 1953.

Monadenia circumcarinata (Stearns). A single dead, bleached shell found on the ground outside the cave. This find constitutes a rediscovery of the species. (AGS No. 9419.)

29. PINNACLE POINT CAVE. Sec. 7, T3N, R15E, MDM, USGS Stanislaus Quad.; Western Spel. Inst., C-160, Raymond deSaussure coll., January 29, 1954. Found on the floor of the cave in the zones of twilight to total darkness.

Monadenia mormonum (Pfeiffer). Two dead and broken juveniles.

Helminthoglypta cypreophila (Binney & Bland). Two adults and two juveniles, dead.

MARIPOSA COUNTY

30. CAVE OF ORPHEUS. Sec. 4, T3S, R18E, MDM, USGS Yosemite Quad.; Western Spel. Inst., C-36, C-39, and C-41, Raymond deSaussure coll., March 8, 1953. Taken at several locations, including a lake at the bottom of the cave.

Helminthoglypta cypreophila (Binney & Bland). Six adults and three juvenile shells, all dead.

31. MILLIPED CAVE. USGS Sonora Quad., near Bower Cave; Western Spel. Inst., C-22, Raymond deSaussure coll., May 25, 1953. On the floor in the twilight zone.

Monadenia mormonum (Pfeiffer). A single living juvenile specimen.

32. McLEAN CAVE. Sec. 20, T2S, R18E, MDM, USGS Yosemite Quad.; Western Spel. Inst., C-146, Raymond deSaussure coll., November 16, 1953. On the floor in the twilight and total darkness zones.

Monadenia hillebrandi mariposa A. G. Smith, n. ssp. Sixteen adult shells and four juveniles, all dead. Type lot.

Helminthoglypta allyni (Berry). Four adults and one juvenile, dead.

Pristiloma chersinella (Dall). One dead adult.

33. BARBER CAVE. Close to McLean Cave. Western Spel. Inst., C-147 and C-148, Raymond deSaussure coll., November 16, 1953. In the zone of total darkness.

Monadenia hillebrandi mariposa A. G. Smith. One adult and one (broken) juvenile, dead.

Helminthoglypta allyni (Berry). One living adult and four dead shells (three immature).

FRESNO COUNTY

34. CHURCH CAVE. Near Boyden's Cave; Western Spel. Inst., C-132, C-133, and C-134, Raymond de Saussure coll., September 19, 1953. Various locations in the zones of twilight and total darkness.

Monadenia hillebrandi (Newcomb). One adult and one juvenile (broken), dead.

Helminthoglypta ferrissi Pilsbry. One very large adult, dead; one fragment; and one young living specimen.

Ammonitella yatesi allyni Chace. Five adults, dead.

Pristiloma gabrielinum (Berry). One living adult; three dead adult shells (one badly broken).

35. CAVE No. 12-1. About 9 miles sse of Badger; Stanford Grotto, 9, Arthur Lange coll., July 2, 1952. Found on the floor.

Haplotrema alameda fieldi Pilsbry. One dead adult shell.

36. WINDY CLIFF CAVE. Across the river from Boyden's ^aCave, Kings Canyon Nat. Park, near Cedar Grove. Taken from the floor in the back section of the cave in total darkness.

Pristiloma gabrielinum (Berry). A single dead adult specimen.

TULARE COUNTY

37. HAUGHTON'S CAVE. Balch State Park. Western Spel. Inst., A-18, Raymond deSaussure coll., July 8, 1952. Taken in "total darkness about 300 feet below ground [level]."

Helminthoglypta tularensis (Hemphill). Two dead bleached adults, one broken.

38. CAVE No. 12-19. About 14 miles nne of Springville; Stanford Grotto, 115 and 116, Raymond deSaussure coll., August 8, 1953.

Helminthoglypta tularensis (Hemphill). Two young shells and a fragment referable to this species.

Haplotrema costatum A. G. Smith, n.sp. Two adults and one immature, dead. Type lot.

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